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EPAct Program Update for DOE

Status and Budget

March 4, 2009

Status of Testing and Fuel Blending

- Phase 1 testing complete
  - 75°F testing of 19 vehicles on 3 fuels (E0, E10, E15)
- Interim FTP-cycle testing complete
  - 75°F testing of 6 vehicles on 3 fuels (E0, E10, E15)
- Phase 2 testing complete
  - 50°F testing of 19 vehicles on 3 fuels (E0, E10, E15)
- Currently preparing to launch Phase 3 (main fuel matrix) with reduced scope due to uncertain funding
  - 75°F testing of 10? (originally19) vehicles on 26 fuels (E0, E10, E15, E20)
- Test fuel development being done by Haltermann and ASD
  - EPA defines fuel recipes
  - Haltermann prepares hand blends, bulk blends and performs fuel analyses
- 22 of the 26 fuels needed in Phase 3 have been blended in bulk
  - 13 have been delivered to SWRI

Test Results to Date

- Preliminary Results for 75°F
  - Decrease in cold start NOx for E10 and E15 compared to E0
    - No statistically significant change in overall NOx emission for composite drive cycle
  - Decrease in CO and HC emissions in composite drive cycle
  - PM results are mixed, no clear trends
  - Acetaldehyde and ethanol emissions increase with fuel ethanol level
  - Findings are consistent with DOE's mid-level blends report

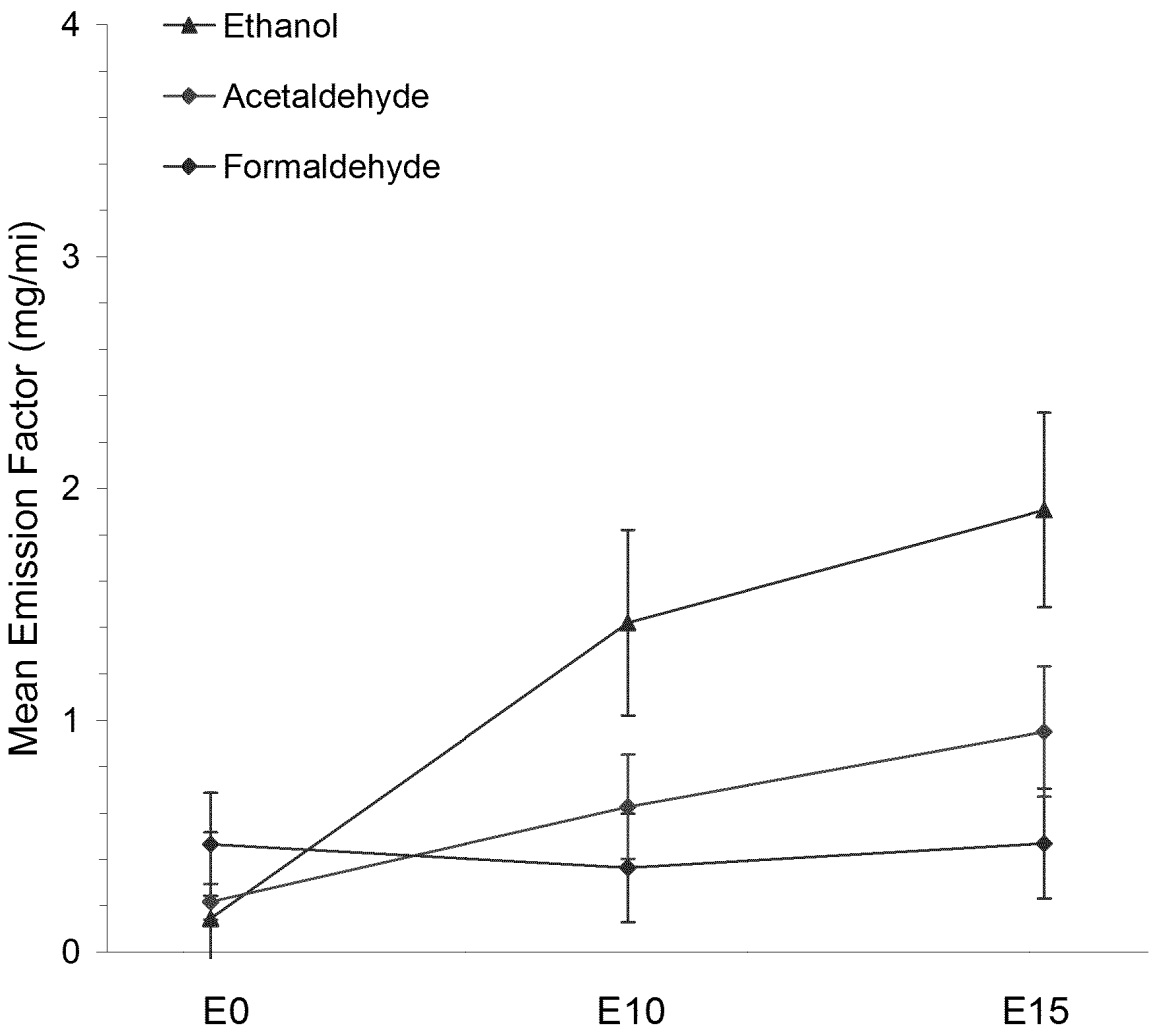
Phase 1 Criteria Emission Impacts

(Categorical Analysis via Mixed Model, p≤0.05 or p≤0.10)

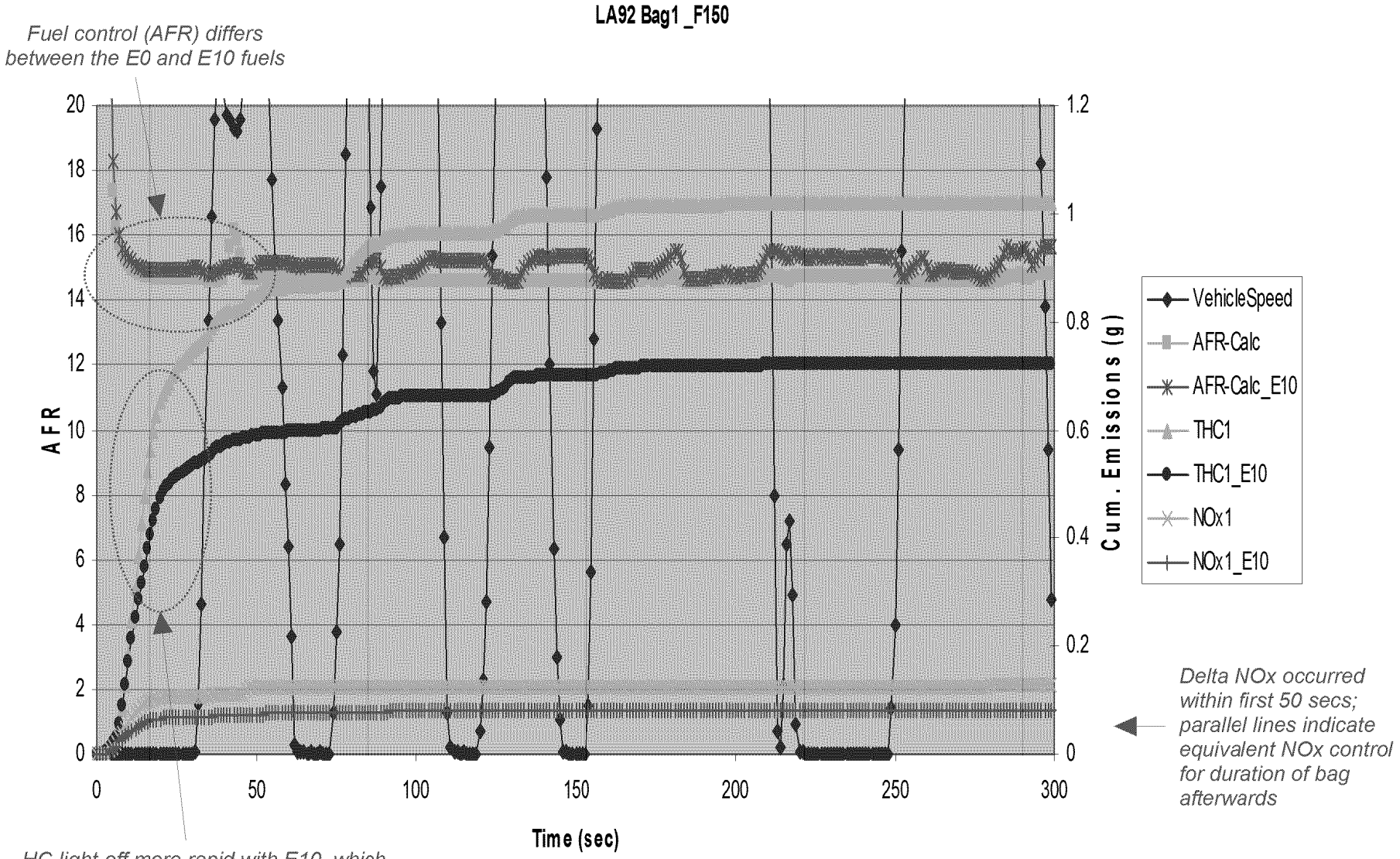
	E10 vs. E0 Relative Difference (%)				E15 vs. E0 Relative Difference (%)			
	Bag 1	Bag 2	Bag 3	Comp	Bag 1	Bag 2	Bag 3	Comp
NOx	-21.6				-18.3			
THC	-11.1		-27.8	-10.2				-9.8
CO	-14.6		-35.6	-13.8	-16.4		-30.5	-13.3
NMHC	-13.3		-38.1	-12.8			-35.4	-14.5
CO2	-1.5	-1.3	-1.0	-1.3	-0.8	-0.9	-0.6	-0.9
PM		-17.3	30.4		24.8		59.4	

	E15 vs. E10 Relative Difference (%)			
	Bag 1	Bag 2	Bag 3	Comp
NOx				
THC				
CO				
NMHC				
CO2	0.7			0.4
PM	21.9			18.5

Effects on Key Toxics



Example of modal and OBD data showing source of emissions changes between E0 and E10 fuels for one vehicle



Caveats to Phase 1 Results

- Phase 1 fuels were chosen to approximately represent how in-use ethanol blends might look in an RFS2 world
  - Goal was to get a preview of ethanol impacts for RFS2 proposal
- However, **multiple properties change between these fuels besides ethanol level**
  - Resulting dataset cannot be used to assign quantified emission effects to ethanol specifically without the rest of the data from Phase 3
  - Meaningful fuel effects modeling cannot be done using resulting dataset alone

PROPERTY	UNIT	METHOD	FUEL		
			E0	E10	E15
Ethanol Content	vol. %	D5599	<0.1	9.35	14.5
T50	ºF	D86	215	209	182
T90	ºF	D86	324	319	310
RVP	psi	D5191	9.17	9.05	8.91
Aromatics	vol. %	D1319	29.3	22.9	18.7
Olefins	vol. %	D1319	6.4	5.7	5.6
Benzene	vol. %	D3606	0.48	0.49	0.46
S	mg/kg	D5453	23	23	21
RON	-	D2699	93.4	93.7	93.9
MON	-	D2700	83.5	84.9	84.6
(R + M)/2	-	Calc.	88.5	89.3	89.2

Budget Considerations Going Forward

- Current program cost estimates significantly exceed original projections
  - Unrealistically low original cost estimates by SWRI
    - Underestimation of base program cost : $ Ex. 4 - CBI
      - Base program cost estimate went up by Ex. 4 - CBI between January 7, 2009 and February 5, 2009
      - Unexpectedly high cost of "coming up to speed": Ex. 4 - CBI
      - Additional checkout tests to resolve HC analyzer saturation and secondary dilution ratio issues in Phase 2: Ex. 4 - CBI
      - Higher than originally estimated test replication rate: Ex. 4 - CBI
  - Fuel cost increase (modified fuel development protocol): Ex. 4 - CBI
  - Additional tasks:
    - EFM resolution: Ex. 4 - CBI
    - Fuel matrix redesign: Ex. 4 - CBI
    - FTP testing: Ex. 4 - CBI
- Current shortfall: **Ex. 4 - CBI**

Options to Reduce Cost

- Delay testing of CRC fuels: $195,000
- Reduce the number of test fuels
  - Reduction of the number of fuels by 1 would drop the G-efficiency of emission models below the minimum acceptable limit of 50%
    - Coverage drops, fuel effects become confounded very fast
- Reduce the number test vehicles
  - Reduction of the number of vehicles from 19 to 15 doubles the probability of getting a non-significant result in emission models. The power of the statistical test of 0.80 is the lowest acceptable in std practice (0.95 was used in AutoOil)
  - Reducing the number of test replicates from 2 to 1 has an even stronger impact
- Eliminate continuous THC, NOx…. measurements in raw exhaust
  - Would make critical types of information unavailable
  - Minimal savings
- Reduce the scope of exhaust HC speciation
  - Data necessary for AQ modeling and toxic emission factors
    - Phase I and II data not adequate due to fuel blending problems
- Work with SWRI to reduce program cost
- Obtain additional EPA funds
- Request additional DOE support

EPAct Cost Estimator

Item	Cost	Comments
Cost of Phase 3 (lower limit) - EPA estimate	Ex. 4 - CBI	
Funds currently available from the EPA		
Additional funds from EPA		TBD
Funds "released" by DOE due to reduced scope of Phase 3		
Additional funds from DOE		TBD
Scaling back of the number of vehicles to 15		
Scaling back of exhaust HC speciation by 50%		
Elimination of continuous THC, NOx…… measurements in raw exhaust		minimal
Total		
Additional funding needed to test 15 vehicles while scaling back HC speciation by 50%		

Back-up Slides

Revised EPAct Fuel Matrix

Phase 3
Base Program (EPA)
(Fuels 1-16) →

Phases 1 and 2
RFS 2 Subset (EPA/DOE)
(Fuels 17-19) →

Phase 3
Additional Fuels (DOE)
(Fuels 20-29) →

E85 (DOE) →

CRC Additional Fuels →

Fuel #	T50 °F	T90 °F	ETOH %	RVP psi	ARO %
1	150	300	10	10	15
2	240	340	0	10	15
3	220	300	10	7	15
4	220	340	10	10	15
5	240	300	0	7	40
6	190	340	10	7	15
7	190	300	0	7	15
8	220	300	0	10	15
9	190	340	0	10	40
10	220	340	10	7	40
11	190	300	10	10	40
12	150	340	10	10	40
13	220	340	0	7	40
14	190	340	0	7	15
15	190	300	0	10	40
16	220	300	10	7	40
17	215	325	0	9	30
18	202	325	10	9	25
19	195	325	15	9	23
20	160	300	20	7	15
21	160	300	20	7	40
22	160	300	20	10	15
23	160	340	20	7	15
24	160	340	20	10	15
25	160	340	20	10	40
26	150	340	15	10	40
27	190	340	15	7	15
28	190	300	15	7	40
29	TBD	TBD	85	TBD	TBD
30	150	325	10	10	40
31	160	325	20	10	15

Revised Fuels

Projected Schedule Going Forward

- Launch of Phase 3 testing: Mid-February 2009
- Completion of Phase 3 testing: Early December 2009
- Reporting: December 2009 – mid-March 2010